SNS IPM status

IPM experience

An IPM design has been developed which performs well on RHIC and will meet the requirements of SNS.
The sensitivity of these IPMs to rf, radiation, and electron backgrounds is far less than the original RHIC design.
The SNS IPM will be based on RHIC design with additional noise and electron shielding.

SNS status

Two digitizer cards, power supplies, PCI crates, microchannel plates, electron generator arrays and high voltage relays have been ordered.
Preliminary design of 250 Gauss dipole permanent magnet is finished. Multipoles will be acceptable to SNS requirements.
Shop drawings of vacuum chamber are being prepared. Shops will start on chamber in February
Collector circuit board layout is finished.
Prototype amplifier is designed.

Committee findings and action items

Ionization profile monitor – IPM will be the only handle on transverse emittance of beam in ring; it should not be sacrificed. However, this device offers the risk of soaking up development resources ad infinitum. Achievable design goals should be established and distractions avoided. Magnets will show up as high cost item; they must be done right.

Ionization Profile Monitor ---

Critical Findings / Action Items

- **IPM magnets may not be properly included in the baseline budget. Find the money needed for the magnets.**

Permanent magnets are planned. Total cost estimated to be $40k.

Committee Observation - IPM's are the **only way to see the beam profile** beyond the very low power beam required for the 'first step' CD4.

Committee Observation - To commission an IPM takes **one FTE of physicist effort**.

Recommendation - **Identify** the ORNL or BNL **staff member** who will be **responsible** for the IPM.

Willem Blokland

Committee Observation - **Edge focusing and optical aberrations** associated with the curved trajectory through the IPM magnet will be important.

Recommendation - Update the **ring optical model** to include the IPM magnets.

This has been done and magnet design considers multipoles.

Committee Observation - The ring vacuum chamber is a bit **larger than the biggest readily available micro-channel plate**.

-Re-evaluate the geometry of the **MCP gap seams**. This is one important way that the SNS IPM's are different from the BNL units.

The amplifier IPM will have a seam in the middle of the detector and the calibration source will have two seams at the 1/3 and 2/3 position. This eliminates seams in the calibration source lining up with seams in the amplifier.

Magnetic field requirement

Large size of SNS beam places very modest field requirement on IPM. Accurate shaping of electric field has eliminated peak broadening in RHIC. Electric field in SNS will be accurate and 150kV/m.

SNS IPM has 3mm collection channels.

An uncertainty of ±3mm in collection of each signal electron introduces a beam width measurement increase of <1%. This can be achieved with a field of 200Gauss.

A RHIC-type dipole with a single layer of magnet bricks will have a field of 250-300 Gauss.

<u>The type of magnet is immaterial for operation of IPM</u>.

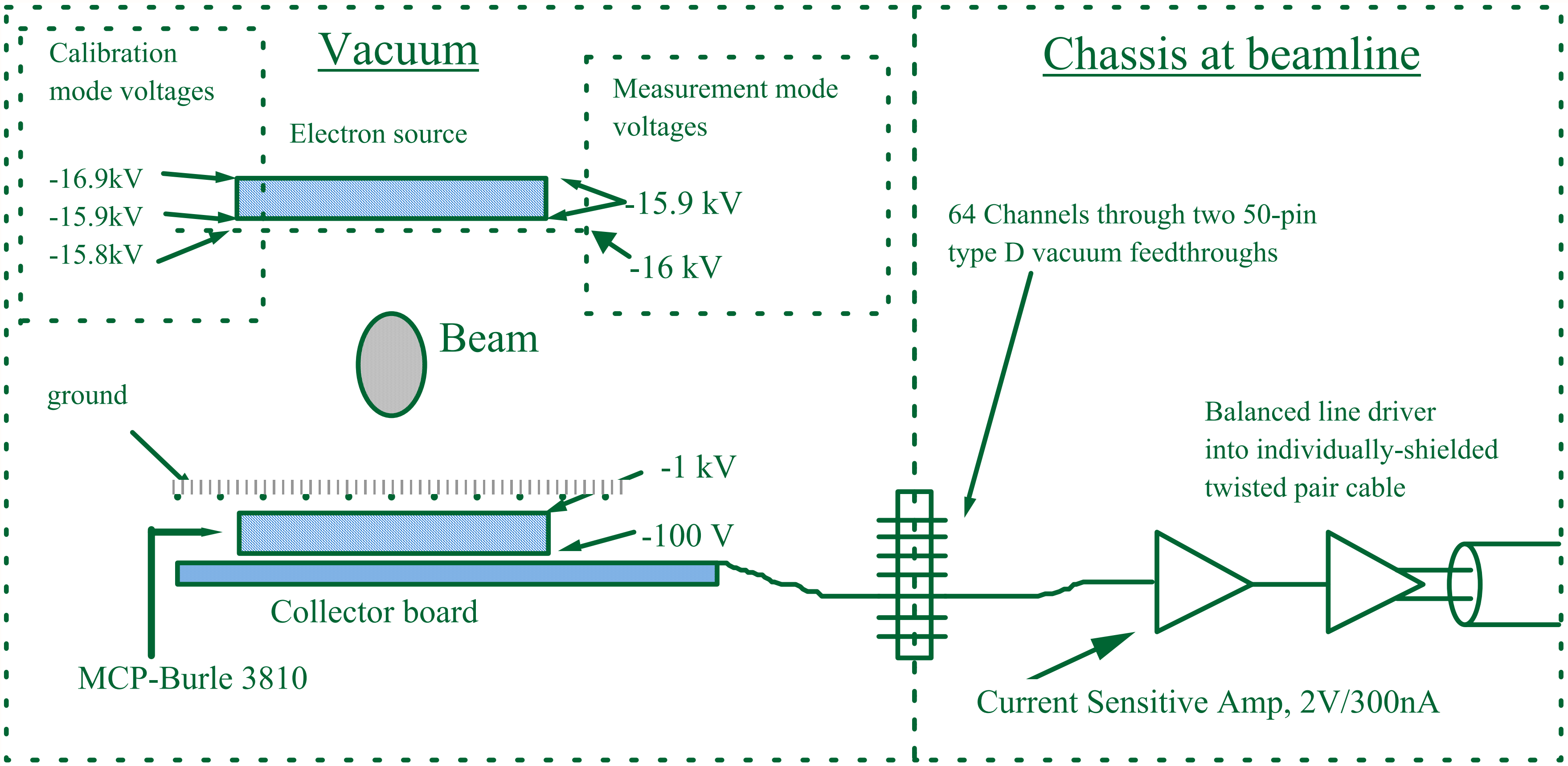
A permanent magnet is inexpensive and needs no control system.

An electric magnet can be turned off and field can be changed if needed.

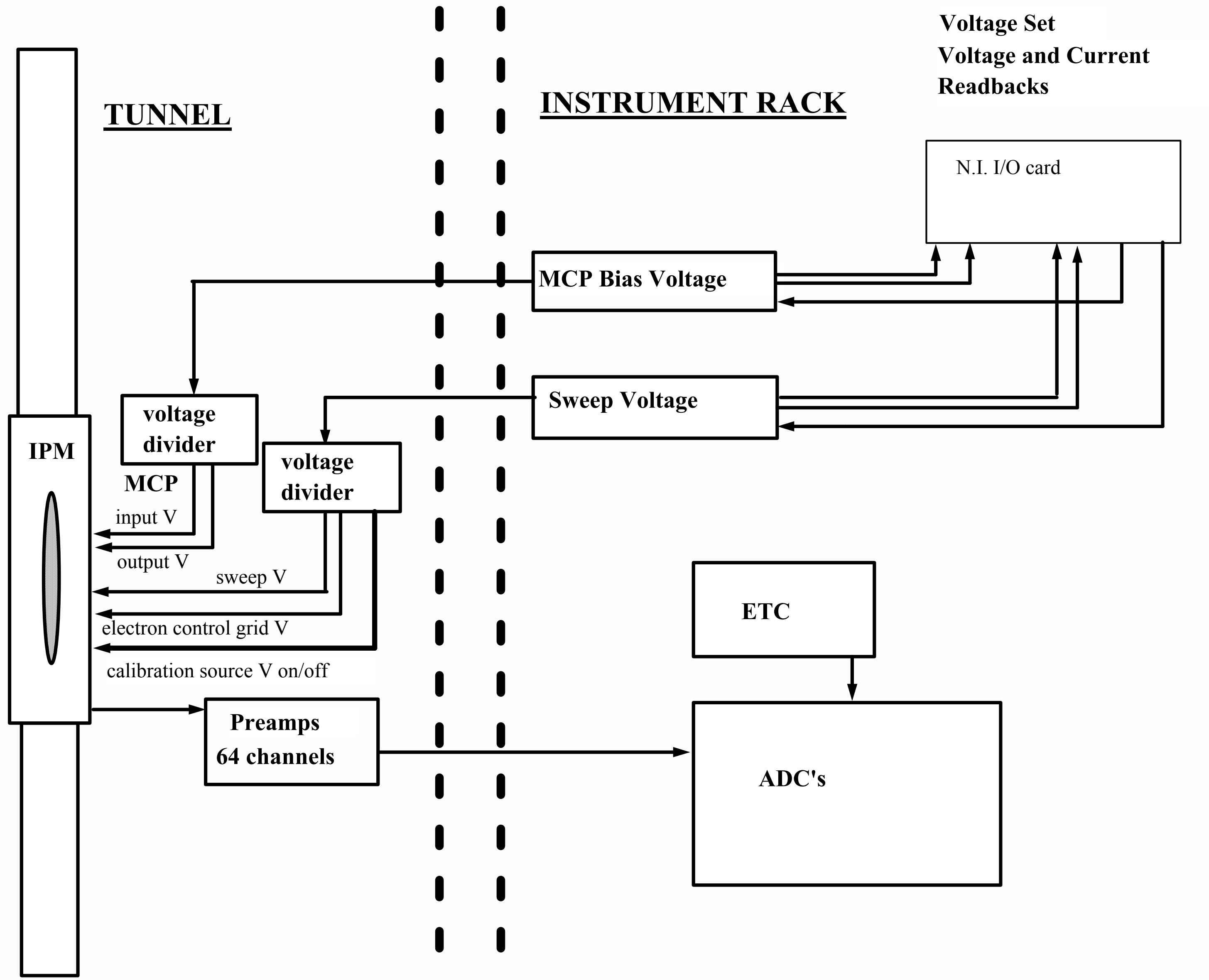
Field shaping is from shaped pole tips so radiation degradation of permanent magnet material cannot cause damaging field errors. Expected radiation in SNS ~100 kR/yr. Magnet material is tested to beyond 17MR with no degradation (170 yrs).

Current plan is to build permanent dipole magnets. Each IPM will have a three-bump system.

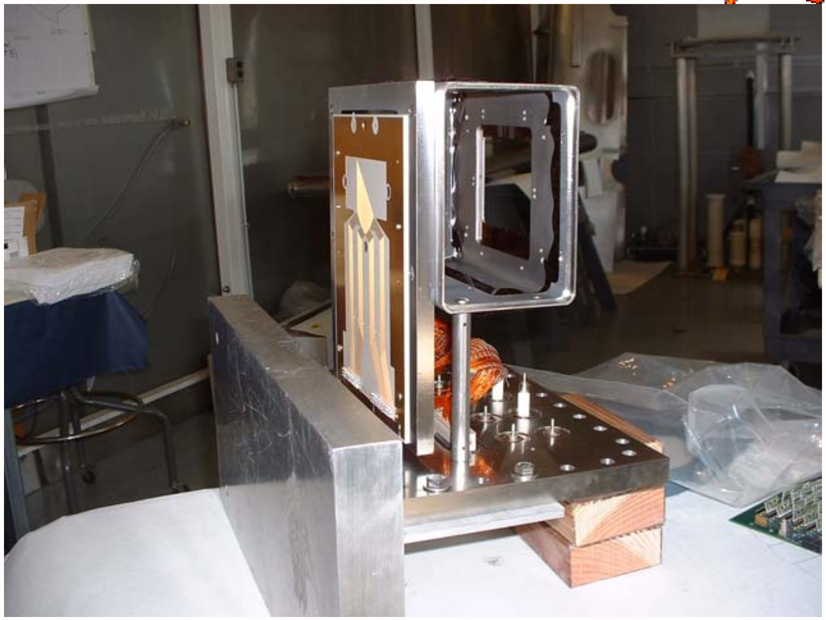
Electrical schematic

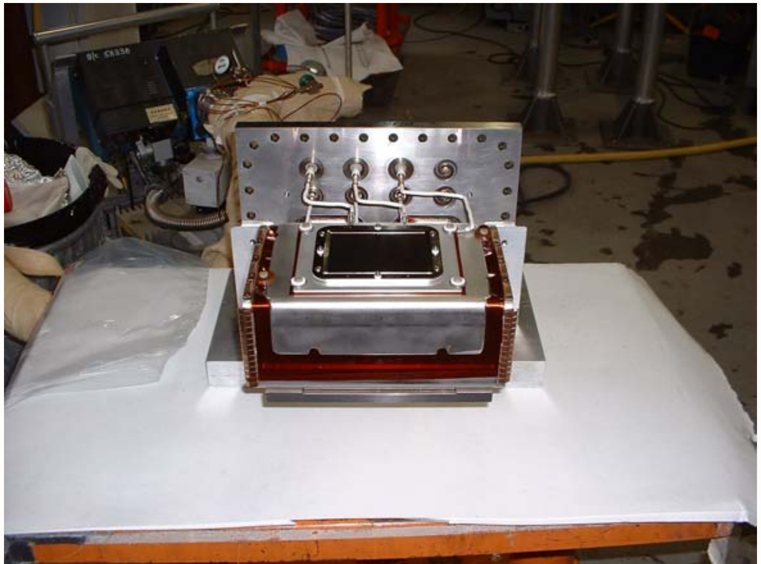


Block diagram

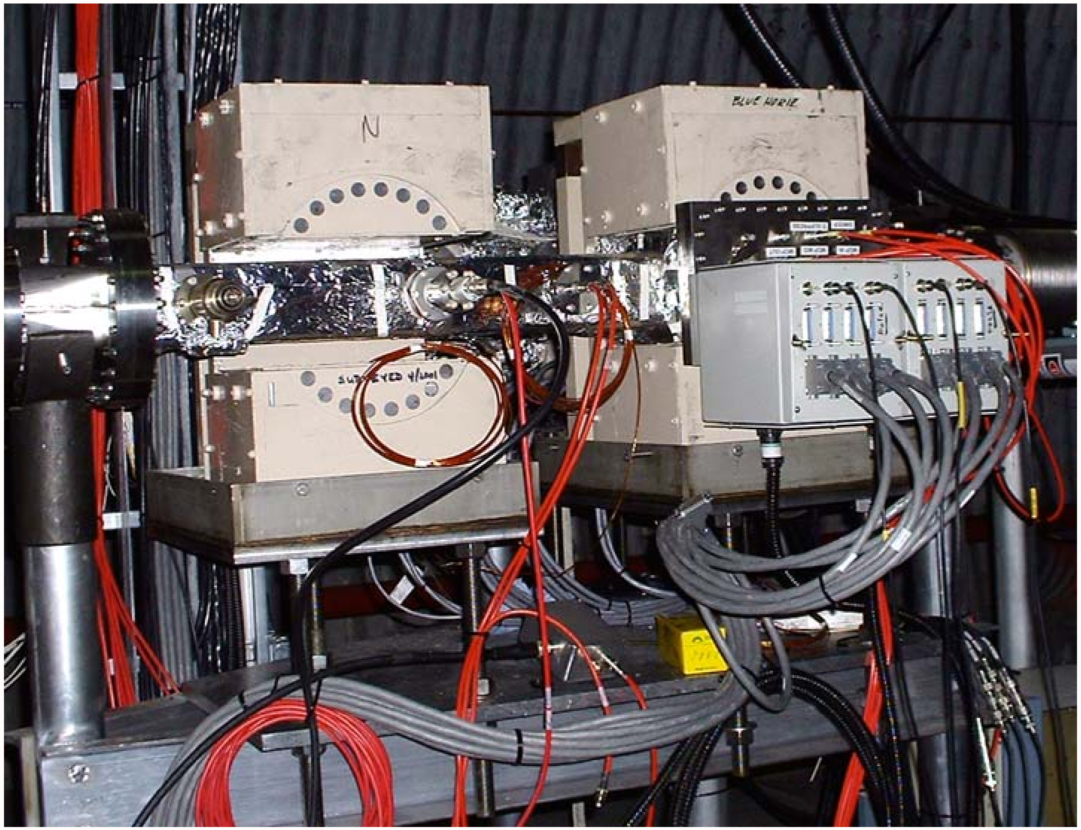


RHIC IPM. SNS will be scaled up version of this.





New IPMs in RHIC showing most of the SNS IPM features

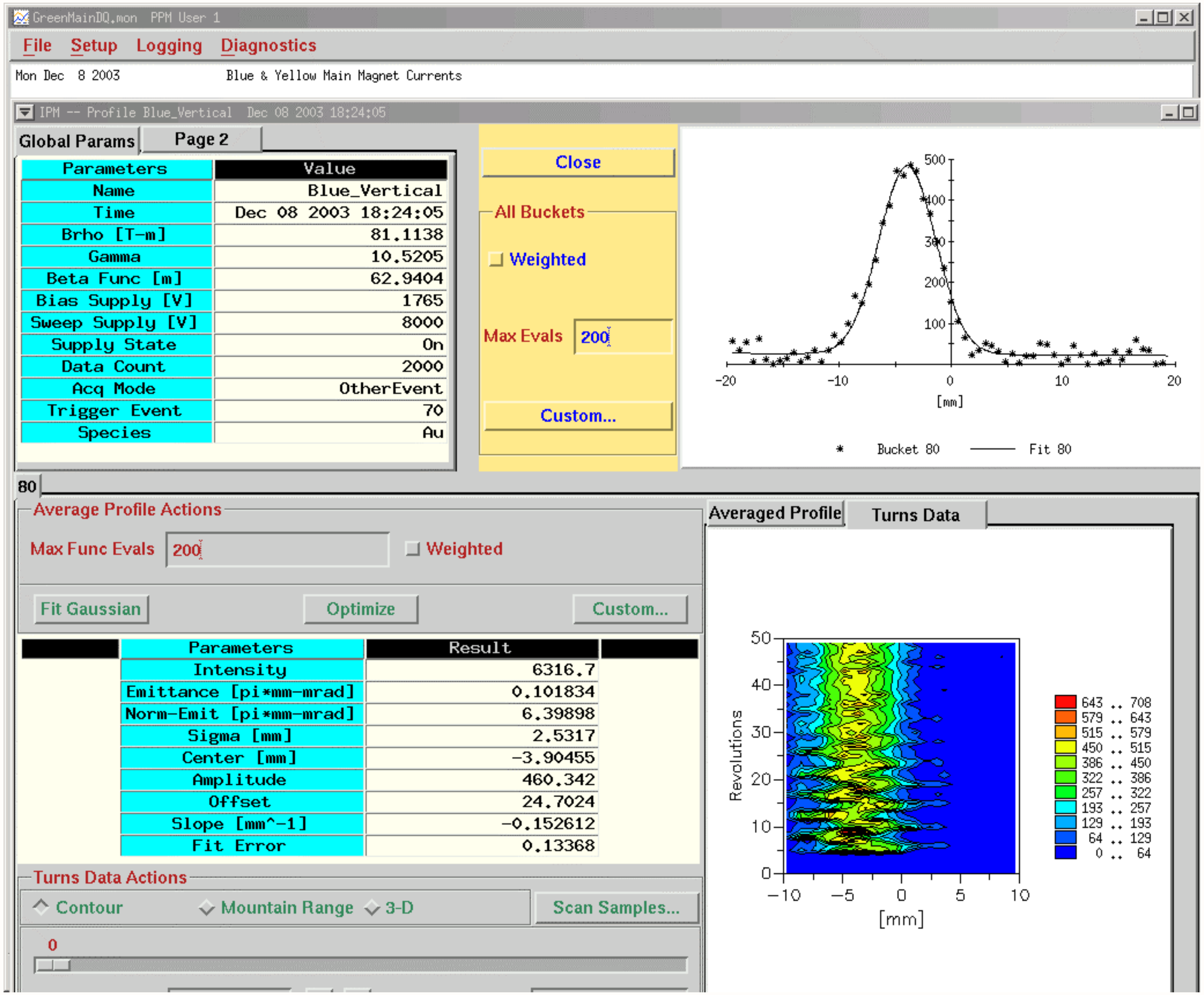


RHIC IPM detector.

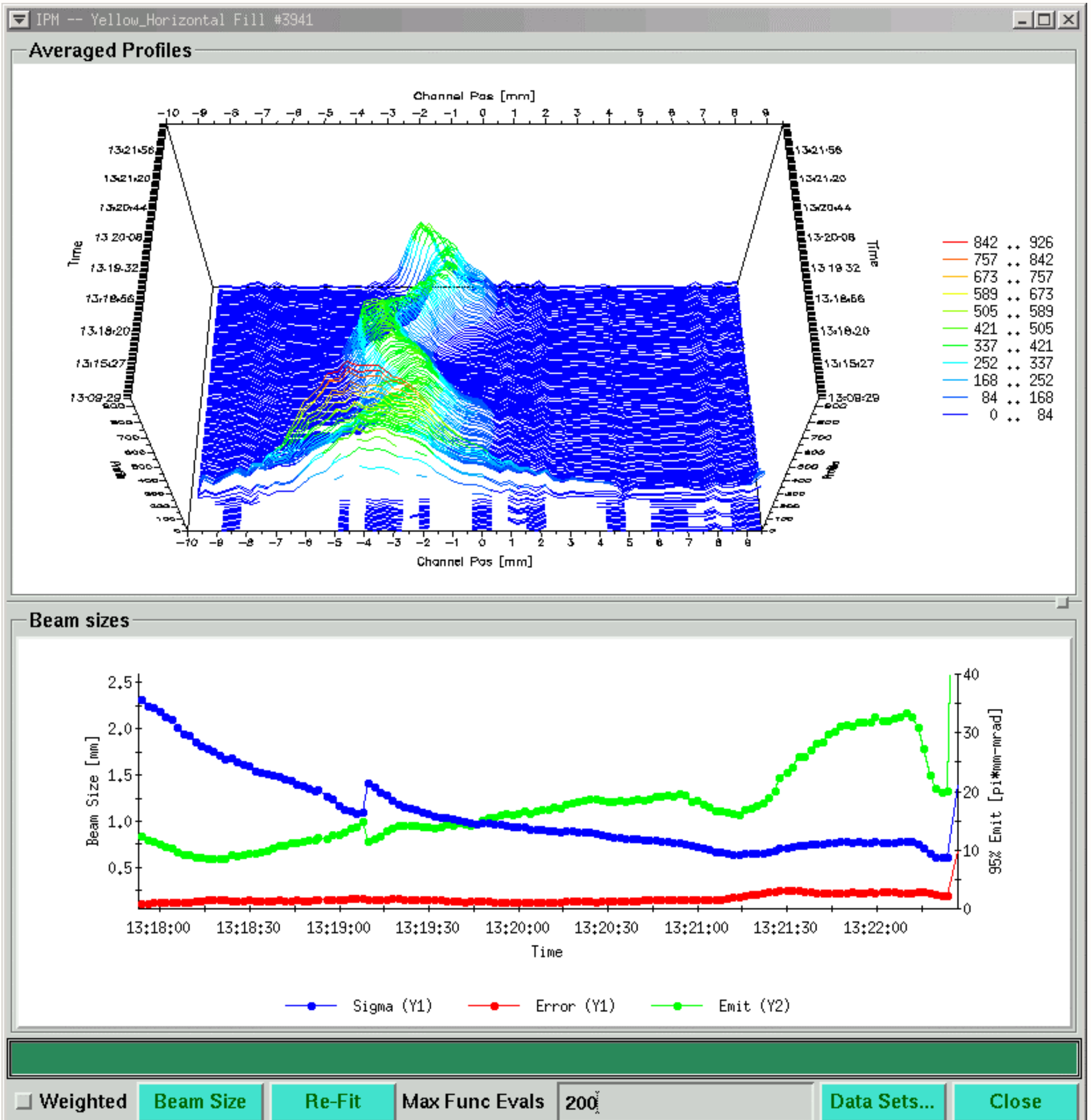
Most of the features seen here will be copied for the SNS IPM.

Signals penetrate the vacuum flange on 50-pin D connector feedthroughs. Amps are attached the to flange and signals carried from the tunnel on twisted pair signal cables.

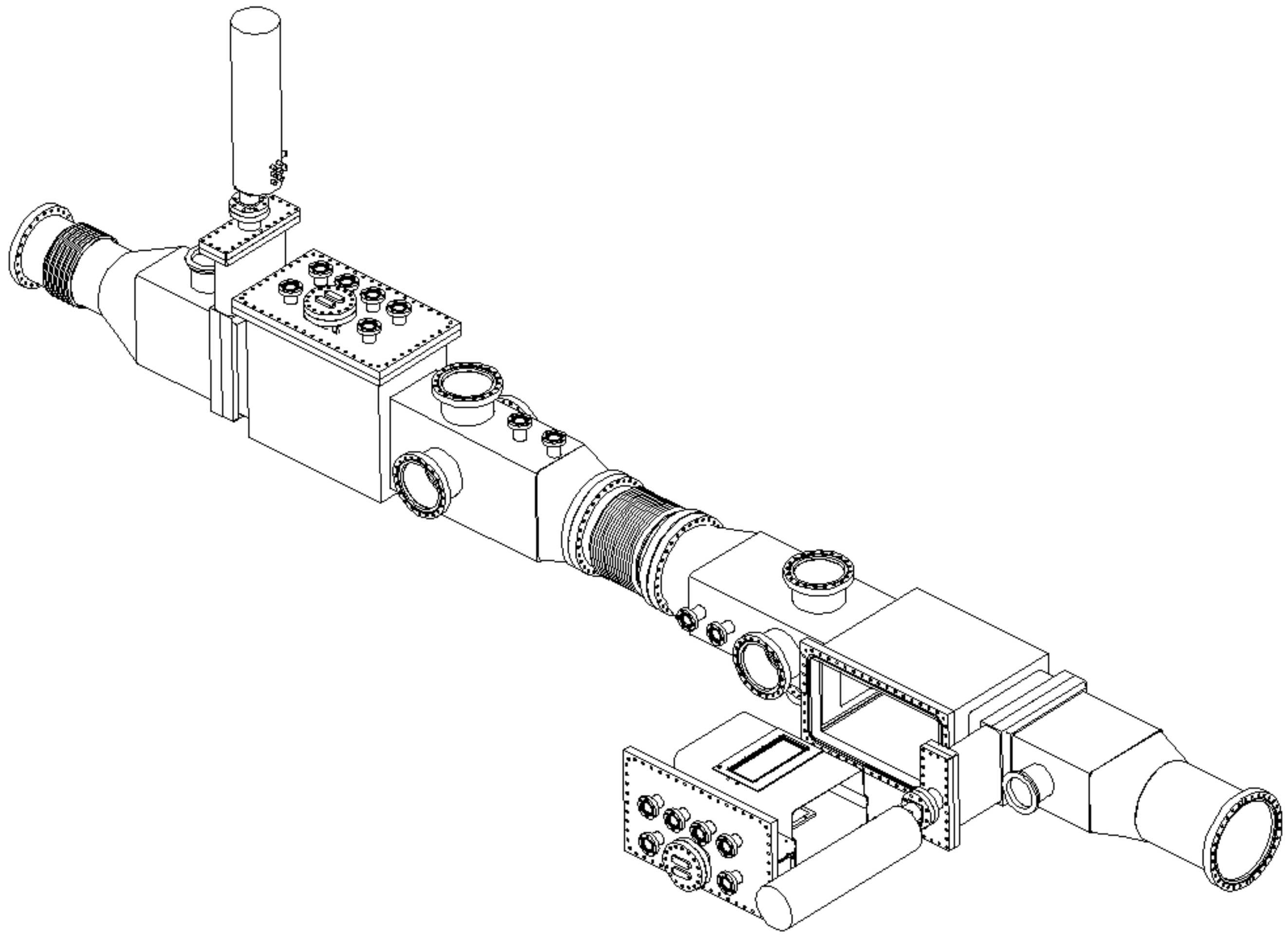
One bunch at injection, betatron oscillations.



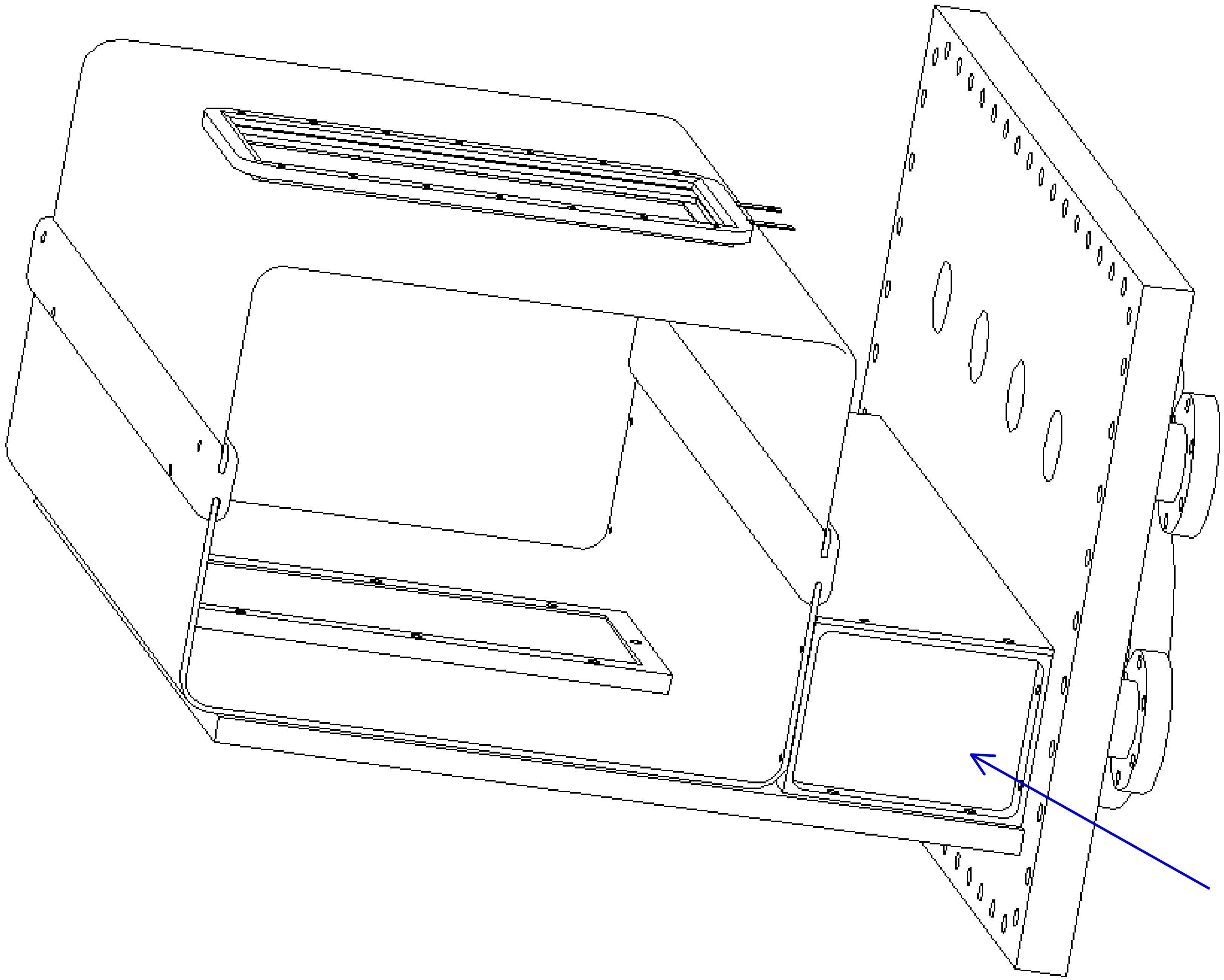
Beam during acceleration ramp



IPM assembly



Transducer insert.



Electronics enclosed by an internal chassis box.

Progress to date

Major accomplishment is developing a design which will perform well in SNS.

The RHIC IPM can be scaled to SNS requirements, and additional noise shielding is being added to the SNS design.

Designed

- Vacuum chambers,
- Detector
- Collector boards
- Magnets

Ordered

- Micro-channel plates
- Electron generator arrays
- Power supplies
- High voltage relays
- PCI crate and digitizer cards for software development

Money and manpower estimates to complete

Estimate to complete SNS IPM. January 27, 2004

Amplifiers	\$5k/detector	\$10k
Magnets	\$5k/magnet	\$40k
Circuit boards	\$2.5k/detector	\$5k
Voltage dividers	\$5k/detector	\$10k
Feedthroughs	\$5k/detector	\$10k
Miscellaneous parts		\$10k
PCI digitizers	\$10k/board	\$160k
Computer crate		\$10k

All the other parts have been ordered and ORNL is responsible for instruments racks and cables.

Manpower (man weeks)

Designer	12
Technicians for assembly and testing	15
Software development	20
Amplifier development	12
Project engineer	20

Not included here are equipment installation, cable connectorization, and final installation testing.

Delivery schedule

Item	Quantity	Delivery date
Detector magnet	2	May 2005
Corrector magnet	4	May 2005
Vacuum chambers	2	July 2004
Detector assemblies	2	Feb. 2005
Amplifiers	4	Apl. 2005
Amplifier power supply modules w. cables	4	Apl. 2005
Bias power supplies	2	Apl. 2005
Sweep power supplies	2	Apl. 2005
Voltage divider chassis	2	Apl. 2005
Digitizer modules	16	May 2005
Control software		May 2005
Recommended spares		
Amplifiers	2	Apl. 2005
Amplifier power supply module	1	Apl. 2005
Voltage divider chassis	1	Apl. 2005
Digitizer modules	4	May 2005
HV power supplies	2	Apl. 2005

Conclusion

RHIC has provided a test platform for developing an IPM which will perform well in the SNS environment. The SNS design will be extremely immune to backgrounds and will have internal calibration sources.

The SNS IPMs will have added rf noise reduction and electron suppression.

a. Higher sweep field
b. Better background electron suppression
c. Accurate channel-channel calibration
d. Accurate sweep field will allow collecting electrons or ions

SNS vacuum chambers, magnets, amplifiers, and transducer are being designed.